Let each apportion a part of the calculation, and then print it in an agreed form. The sterotype plates would be interchanged, and what a private firm does the Government can effect. In this way the English-speaking marine, including many Dutch and German captains, will be at once supplied, and part of the proposed economy and benefit be obtained without waiting for negotiations with France and Germany. HYDE CLARKE

Electrical Phenomenon in Mid-Lothian

I HAVE observed in a daily contemporary a communication quoted from your journal with reference to this occurrence on the 23rd ult.

For the information of those of your readers who are interested in such matters perhaps you will kindly allow me to observe that I also witnessed a similar, or the same, phenomenon that evening.

When driving home from a professional visit in the country, and a mile south of this town, about ten o'clock I was suddenly startled by a peculiar sensation or slight shock, and immediately perceived, ten yards in front, on the road, a bright opalescent luminosity which travelled deliberately away in a northerly direction. This cloud or wave of light covered the whole breadth of the road, and was distinctly visible for some seconds. It seemed to rest entirely on the ground, and in character reminded one somewhat of the illumination resulting from the electric light. I should imagine it was travelling at the rate of twenty miles an hour, as it was going much in the same direction I was, but of course much faster. The part of the road where it showed itself is lined by high trees on both sides in full foliage. I heard no thunder and saw no lightning or meteor to account for the strange and weird-looking light.

The interesting question then arises, What was the nature of this phenomenon?

It will be remembered that the thermometer was for several days at that time above 80° F. in the shade. Might it not be possible, therefore, for a certain volume of air to become electrified, and then, perfectly insulated by the dry surrounding atmosphere, show its existence in this manner as a luminous cloud rushing along the ground?

I may mention in conclusion that my groom, who was driving me at the time, also witnessed the occurrence.

Dalkeith, N.B., August 10, 1885 ROBERT LUCAS

On a Radiant Energy Recorder

A FEW weeks ago I wrote a short article for NATURE under the above title, describing an instrument for the measurement of radiation in heat units which was based upon the principle of the integration of temperature by the distillation of water in vacuo. Since then Mr. Edward Vivian, M.A., has kindly written me a very interesting letter, in which he says that he had several forms of an instrument based upon essentially the same principles, made for him by Messrs. Negretti and Zambra many years ago, and that some of them are still in use in his garden at Torquay. Mr. Vivian's instruments were shown at the British Association (*B. A. Report*, 1856, p. 48) and at the Royal Institution of Great Britain (*Journal R. I.*, 1857, p. 438), but no description of them appears to have been printed, which probably accounts for their not being more generally known.

University College, Liverpool J. W. CLARK

Our Ancestors

THE number of "Our Ancestors" since "the time of the Norman Conquest," mentioned in your last issue by $\left(\frac{1}{2}\right)^n$, and the consequences to be deduced therefrom, have been very interestingly discussed already by Mr. Grove in his presidential address to the British Association at Nottingham, 1866.

Freiburg, Badenia, August 8 N.

THE INSTITUTION OF MECHANICAL ENGINEERS

THE Institution of Mechanical Engineers held their summer meeting at Lincoln last week, under the presidency of Mr. Jeremiah Head, who, in his inaugural address, treated of the relative advantages of iron and steel for the various purposes for which these metals are employed. The reasons why steel *rails* are now used almost to the exclusion of iron are that they can be produced more cheaply, can be manufactured of equally good quality by either the Bessemer or Siemens process with either acid or basic-lined vessels and of almost any iron ore, and they can better withstand abrasion, disintegration, or crushing under heavy rolling loads; for the same reasons steel tires are now almost universally employed. For *ship-building* steel is superior to iron, as, owing to its greater ductility, ships built of the former metal are able to outlive collisions and minor accidents that would be fatal to iron ships. As is well known, owing to the superior tensile strength of steel, Lloyd's Committee agreed in 1877 to allow a reduction of 20 per cent. in weight of scantlings over iron, and in the thickness of plates; Mr. Head argues that, considering a ship's plate is a broad girder, its strength diminishes as the square of the thickness, and that, therefore, although a steel ship would be superior to an iron one of equal weight, an iron ship is likely to retain its form better than a steel one built 20 per cent. lighter. As regards *bridges and roofs*, the employment of iron or steel depends mainly upon the size of the structure; for light edifices, owing to its greater cheapness, iron has hitherto been used, whilst for large spans, where the weight of the structure itself is an important function, steel has been employed in the erection of bridges of spans which could not have been attempted if the engineer had been dependent on iron alone. For *boilers*, except in the matter of corrosion, in which authorities seem to differ as to the resisting power of iron and steel, but appear to be rather favourable to the former, steel is much more advantageous than iron, both on account of its being as cheap, and on account of a steam boiler of the same weight being able to withstand much higher pressures if made of steel than if made of iron; hence boilers, and marine boilers particularly, are now scarcely ever built of iron. The President recommended the application of metal in the construction of the frames of rolling stock and for railway-sleepers. As regards the continued use of wooden sleepers, there can be no question that "it is a form of waste that should be reprehended in the public interest, just as should the use of coal for ballasting or other obviously wasteful purpose. The same timber which would become useless for sleepers in, say, nine years, would last at least a century in the roof or flooring of a house." Another argument advanced, and a most important one, is that the substitution of iron and steel for timber railway-sleepers would not only give an enormous impetus to these industries while the substitution was being effected, but would permanently maintain a population of 100,000, or 3 per cent. of the whole population of the country, for renewals.

Leaving special branches of industry, to refer to special forms in which iron and steel are supplied, the President drew attention to *bar-iron* still maintaining its position, because wherever implements are *made* they come sooner or later to the village blacksmith to be *repaired*, and these find steel harder to work, more difficult to weld, and requiring more care to smith; and therefore the original manufacturer has to adopt a material and construction within the compass of the ideas and resources of the rural repairer.

As regards *castings*, an urgent need has long existed for a material which could be cast in a mould, and which should yet have the toughness and tenacity of wrought iron; and steel, exactly supplying this want, has come very generally into use, more particularly as the cost of steel castings has been greatly cheapened latterly by the employment of the Bessemer and Open Hearth processes; still, steel castings are much dearer than iron ones, because the molten metal is dearer, and the higher melting point of steel compared with iron necessitates more costly moulds. But in a majority of cases in which cast

iron has hitherto been used, mass and stiffness due thereto, are required, rather than great tenacity and ductility, and there is, therefore, likely to be a simultaneous demand for castings of both steel and iron. Concurrently with steel castings, steel *forgings* have gradually been coming more and more into general use for fine and delicate work, where cost is no consideration, and homogeneity and capacity to harden of the very greatest importance.

Steel has practically no grain, and is as strong in one direction as another; thus it is eminently suitable for such work, and is naturally superseding iron completely. The conclusion of the President on the subject of the employment of iron and steel in the arts is one in which upon full consideration all must agree—viz. that the laws of gradual change, and of the survival of the fittest, apply equally in the arts as in nature, and that in the long run the fittest material will prevail according to the peculiarities and necessities of each particular case.

The first paper read at the meeting was by Mr. J. Ruston, M.P., descriptive of Dunbar and Ruston's steam navvy.

This machine may be described generally as consisting of a strong rectangular wrought-iron frame mounted on wheels. On the back end is placed the engine; at the front end rises a wrought-iron tower carrying the top pivot of a crane jib, the lower pivot resting on girders fixed to the main frame. The jib is of twin construction, being composed of two sides united only at the post and at the outer end or point; between them is a long slot, in which swings an arm of adjustable length, depending from a fulcrum fixed on the upper member of the jib; and at the base of the post is a circular platform, on which a man stands to regulate by means of a hand-wheel the "reach," or length of radius of the arm. The scoop or bucket is fixed at the lower end of the arm, and is raised or lowered by the main chain passing over the extremity of the jib. The whole of the movements are controlled by two men, called the "driver" and the "wheelman." The driver raises the scoop while making its cut, swings it round into position for discharging, and back again afterwards, and lowers it down. The wheelman regulates the depth of the cut, releases the scoop from the face of the bank, and opens the door or bottom for discharging its contents.

Supposing the navvy to be in position, the mode of working is as follows:—The bucket having been lowered till its arm is vertical, the wheelman regulates the length of the arm by means of his hand-wheel, so that the cutting edge of the bucket shall get its proper grip of the soil. The driver throws the main chain-drum into gear, and the scoop is dragged forwards and upwards by the chain, describing a circular arc of about 80 degrees. By the time it reaches the top it is fully loaded, and the driver, throwing the drum out of gear, holds it with a foot-brake; at the same instant the wheelman by easing his footbrake allows the bucket to fall back so as to clear itself from the face of the bank. The driver next swings the jib round till the bucket is over the waggon, when the wheelman releases the latch by means of a cord, and the door falling open, the contents instantly drop through. The driver then swings the jib back again, and at the same time lets go the footbrake of the chain drum, thus causing the bucket to descend through a sort of spiral course, until he brings it up sharply by the brake again. The wheelman at the same moment adjusts the fall by means of his brake, so as to lower the bucket to its first position with just the right reach of arm for the next cut. During the fall the door of the bucket closes and latches itself automatically by its own weight; and all is then ready for repeating the operation.

Upwards of a hundred of these machines are now in use, the majority in Great Britain, and the remainder in various parts of the world.

In the discussion of this paper the various speakers testified to the success with which the navvy did its work when excavating materials of various degrees of hardness and toughness.

Mr. John Richardson's paper on recent adaptations of the Robey semi-portable engine was an extension of a paper read in 1873. The engine is erected on a massive wrought-iron foundation plate, to which all the working parts are fixed, together with one of the drum-shaft bearings, and the brackets for carrying the brake-straps and levers. The whole of the strains due to the working of the machinery are contained within the base plate, and are brought, as they should be, near to the position of greatest stability—namely, the ground line; while the boiler is set free from all mechanical strain, and is left to its legitimate purpose of making steam. A specially light engine has been designed for use in countries where there is little facility for transport, wrought iron and steel have been substituted as far as possible for cast iron, with the result of a large saving in dead weight and consequent saving in cost of transport.

A paper on private installations of electric lighting, by Mr. Ralph Neville, is interesting as descriptive of an application in which existing engine power was utilised and modifications made in the governing of the engine to suit the purpose of driving a dynamo machine, in which, as is well known, the action on the engine has to be prompt, the electric lamps acting as visible instantaneous galvanometers. The dynamo employed was a Siemens S9, the lamps being mostly 100 volt 20 candle-power of Edison and Swan make. The current generated is led from the dynamo to a set of switches, by which it can be distributed into five separate circuits, the first exciting the field magnets of the dynamo itself and the others furnishing current for lights in various parts. Certain points are taken as lighting centres, and the electromotive force between them is kept constant; for this purpose small wires are connected with the mains at the required points, and the current to actuate the governor is taken off there, instead of direct from the terminals of the dynamo. The original governor attached to the engine was found to have so great an inertia that its position would remain the same for a very considerable variation of speed, so the author set up an electrical governor.

The regulating part of this governor consists of a double solenoid magnet, placed vertically and wound with insulated copper wire, within which works a double core; and to the cross-piece at the bottom of the cores is linked the long arm of a lever, the short arm of which presses upon the spindle of a double-beat Cornish valve that controls the admission of the steam to the steam-chest. For incandescent lighting in parallel, the wire on bobbins is placed in shunt circuit between the main leads; and the size of wire used is adjusted according to the electromotive force which it is desired to maintain between the mains, so that when the electromotive force is at the right point the cores are suspended within the solenoids by their attraction. Inasmuch as the resistance of the solenoids is fixed, any increase in electromotive force causes an increased current to flow through them, whereby the cores are immediately attracted with an increased force, and are caused to move upwards, thereby acting through the lever to close the valve until the electromotive force has been brought down again to its normal amount. The required movement of the valve is exceedingly small; and this method appears to be the best suited for electric lighting. An automatic expansion-gear, on which the governor might be caused to act, has the disadvantage that, when but few lights are burning, the steam is cut off at so early a period of the stroke that, unless the fly-wheel is exceedingly heavy, a fluctuation occurs in the the light during the revolution of the fly-wheel. In an engine where economy of coal has to be considered probably the best way would be to have an expansion-gear actuated by hand, which can be set approximately to the expansion required leaving the throttle-value to

regulate the speed finally. But where perfect steadiness is desired it is probably better not to cut off much before half stroke, especially if a single-cylinder engine is used. The use of accumulators as regulators would of course prevent a great deal of the fluctuation, and would permit of the steam being cut off much earlier without causing any apparent unsteadiness in the light.

The electric governor was fixed on the engine and worked for the first time on January 13 last. The improvement was remarkable, the lights remaining steady, without the sudden alternations of brightness and dulness which had occurred before. But it was still found that with any considerable variation of boiler pressure or of load the electromotive force in the mains varied more than was thought conducive to long life in the lamps. As however it was found that, by augmenting or diminishing the weight suspended from the core bars, the electromotive force could be brought back to its normal amount, it occurred to the author to fix an upright cylinder in direct communication with the boiler, and to make its piston-rod press upwards on the core-bars: the diameter of the cylinder being experimentally determined by observing the weight necessary to be added or removed for certain variations in boiler pressure. This arrangement caused a very great improvement; and when the load was approximately the same it maintained the electromotive force constant under very considerable variation of steam pressure. When, however, the load was varied very considerably, say from one lamp to a hundred, it was found that more variation took place in the electromotive force than was desirable.

The arrangement was accordingly modified by causing the piston-rod to act upon a lever, and by introducing a second cylinder supplied with steam from the steam-chest, the second piston-rod acting not upon the same lever but upon the other side of the fulcrum. The end of the lever was furnished with a steel knife-edge, bearing against another knife-edge set at right angles to it upon the prolongation of the core-bars. The cylinders were also both of them made larger, and were placed so that they could either of them be moved nearer to or further from the fulcrum of the lever, whereby the resultant effect of their differential power could be easily adjusted. This arrangement answered very well indeed, and it was found that the lights could be varied from 1 to 100 and the boiler pressure from 30 lbs. to 60 lbs. with but very slight variation of electromotive force in the mains: provided of course there was sufficient steam to do the work required. It is also quite easy to cause the electromotive force to rise as the load on the engine increases—or in other words as more current passes through the main—by simply giving greater leverage to the piston connected with the steam-chest. In fact with this arrangement the electromotive force can be maintained practically constant, or can be made to vary in any desired manner with variations of steam pressure or of load.

Several experiments were made by Mr. Richardson and the author on the action of this regulator, the results of which were as follows:—When the load on the engine was allowed to remain constant, with only one lamp alight, it was found that while the steam pressure was allowed to vary between 31 lbs. and 55 lbs., the electromotive force remained constant at 90 volts. Afterwards, with the same extent of variation in steam pressure, and with the load also varying from 1 lamp to 91 lamps, the electromotive force varied only 2 volts—from 91 volts to 93 volts. The introduction of this governor has, in the author's opinion, contributed very largely to the duration of the lamps also. The discussion of this paper, which was very full, was mainly upon the governor described and the governing of engines for electric work, the necessity of an electric governor being maintained on the one side, whilst on the other it was held that all that was required was an ordinary mechanical governor of great sensibility.

The Rev. E. Venables, at the conclusion of the discussion, invited electrical engineers to advise the Cathedral authorities, as they should like to see, as a practical result of the visit of the Institution of Mechanical Engineers to Lincoln, the lighting of Lincoln Cathedral by electricity.

A VOLTAIC CELL WITH A SOLID ELECTROLYTE

I BELIEVE that there has never hitherto been made a voltaic cell with a solid electrolyte which was capable of generating the smallest sensible current—at least at ordinary temperatures. Sir William Thomson found that when warm glass was placed between plates of zinc and copper, the existence of an electromotive force was indicated by an electrometer in connection with the metals, and Profs. Ayrton and Perry extended the observation to the cases of paraffin-wax, gutta-percha, indiarubber, and shellac. But it is needless to say that with electrolytes of such enormous resistance no current could be generated of sufficient strength to be detected by any galvanometer, however delicate.

On June 27 I exhibited to the Physical Society a little cell consisting of plates of silver and copper, between which was contained a mixture of 1 part of copper-sulphide with 5 of sulphur. When this cell was connected with a reflecting galvanometer it produced a current by which the spot of light was at once deflected off the scale, copper being the positive pole. The electromotive force was found to be ·07 volt, and the internal resistance 6537 ohms. The current, therefore, though far more than merely sensible, was small. Attempts were made to reduce the internal resistance by diminishing the proportion of sulphur contained in the mixture, but it appeared that as the sulphur was diminished the electromotive force was also diminished, until, when there was no free sulphur at all, the cell failed to produce the smallest measurable current.

It occurred to me that the sulphur owed its efficacy to the fact that it formed a film of silver sulphide upon the surface of the silver plate by direct combination. I therefore made a cell thus:—A thin layer of copper sulphide was spread upon a copper plate and compressed into a compact mass against a surface of polished steel. A layer of silver sulphide was then spread upon the copper sulphide, and the cell was completed by pressing a silver plate upon the silver sulphide. The current which this cell produced through the shunted galvanometer was considerably stronger than that generated by the cell first described; but still the result was not quite satisfactory, and there seemed to be indications of short-circuiting, which I thought might possibly be due to the penetration of particles of copper sulphide through the layer of silver sulphide. The silver plate was therefore removed from the cell, and, having been brushed over with a weak solution of sulphur in bisulphide of carbon, it was heated over a gas flame, and soon became covered with a uniform and continuous coating of sulphide. The heating was continued until all the free sulphur was evaporated. When the cell was reconstructed with this prepared plate it produced a current of 6800 micro-amperes through an external resistance of ·2 ohm, and was able to deflect the pivoted needle of an ordinary coarse galvanometer.

The dimensions of the cell are as follows:—The copper and silver plates measure $2\frac{1}{2}$ inches by 2 inches; the thickness of the two layers of sulphide (strongly compressed) is about 1-20th inch; the E.M.F. is ·053 volt, and the internal resistance is therefore about 7 ohms.

This cell seems to be exactly analogous in its action to a Daniell cell in which plates of copper and zinc are immersed in solutions of copper sulphate and zinc sulphate. Silver is probably the best (or only) possible metal for the positive plate, but some other metal might perhaps be substituted for the copper with advantage.

SHELFORD BIDWELL